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Design of the Preamplifier Integration Testbed for the National Ignition Facility (NIF)*

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The systems design of the preamplifier integration Testbed (PAIT) is described. The PAIT is a pre-prototype of the compact, stand-alone preamplifier module (PAM) for NIF. The PAIT includes two Nd:glass amplifier stages, a spatial beam shaping optical system, transport optical systems, power and control electronics, and a modular optical bench with a system volume of approximately 45 x 76 x 432 cm^3. The net gain of the system is $>10^{10}$.

The NIF is a 1.8 megajoule, 500 terawatt frequency tripled Nd:glass laser system comprised of 192 beamlines. The Optical Pulse Generation (OPG) System, master oscillator creates the initial optical pulse which is temporally shaped and transported from the master oscillator room (MOR) to the preamplifier via fiber optical distribution system. The MOR optical signal is amplified to the several joule level and spatially formatted in the preamplifier module (PAM) on an individual beamline basis. The beam is then optically relayed and injected into the main laser optical system.

The preamplifier design for NIF is based on the concept of a smart, stand-alone, high gain, high fidelity, reliable, packaged laser system to inject an independent beam into each NIF main amplifier beamline and which can be manufactured in moderate quantities. Based on the NIF Component Development effort at LLNL, the basic gain and optical system elements have been developed. The principal purpose of the PAIT is to package these laser/electrooptic assemblies in a modular like structure which includes all the laser, optical, electrical, and mechanical systems required to operate a fully integrated testbed to evaluate the total system performance.

The PAIT consists of seven basic optical assemblies: fiber injection and MOR isolation, diode pumped regenerative amplifier cavity, optical beam shaping, flashlamp pumped multipass rod amplifier cavity, and optical isolation from the main amplifier backreflections. The regenerative amplifier cavity uses two 5mm diameter glass rods with a total gain of 10^7 and operates at 1 Hz. The beam shaping section generates a square beam with a specific intensity profile to pre-compensate for gain roll-off in the main amplifiers. The multipass amplifier cavity is a four pass design using a flashlamp pumped 45 mm diameter glass rod. The total gain is 10^4 and operates at a rate of at least one shot every 20 minutes. The final optical isolation assembly is to protect the multipass amplifier from backreflections using a 45mm Faraday rotator isolator, which in conjunction with a half wave plate switches the beam out of the cavity to exit the PAIT.

The electrical system consists of diode array drivers and Pockel's cell pulsers for the regenerative amplifier, multipass amplifier flashlamp power conditioning unit, ion pump controllers, power distribution system, timing system triggers, and an embedded controller.

These components are based on commercial off-the-shelf hardware where possible. The control system architecture and software is currently being developed.

The principal structural/integrating element for PAIT is the optical bench which is based on an "I" beam cross-section type structure with a 2 inch thick optical honeycomb breadboard as the web. All of the optical, electrical, and mechanical mounts are supported by this bench except for the flashlamp power conditioning unit which must be reduced in size to fit on the bench. The overall dimensions of the PAIT are 45 x 76 x 432 cm^3.

In our presentation we will discuss the design and the initial operation of the PAIT.

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